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UTILITY PATENT APPLICATION TRANSMITTAL

(Only for new nonprovisional applications under 37 CFR 1.53(b)

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First Named Inventor or Application Identifier

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APPLICATION ELEMENTS

See MPEP chapter 600 concerning utility patent application contents.

ADDRESS TO: Assistant Commissioner for Patents
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1. [X] Fee Transmittal Form
(Submit an original, and a duplicate for fee processing)

2. [X] Specification *[Total Pages* -16]
(preferred arrangement set forth below)
- Descriptive title of the Invention
- Cross References to Related Applications
- Statement Regarding Fed sponsored R & D
- Reference to Microfiche Appendix
- Background of the Invention
- Brief Summary of the Invention
- Brief Description of the Drawings *(if filed)*
- Detailed Description
- Claim(s)
- Abstract of the Disclosure

3. [X] Drawing(s) *(35 USC 113)* *[Total sheets -7]*
4. [X] Oath or Declaration *[Total Pages - 3]*

a.1. [X] Newly executed (original or copy)
a.2. [] Unexecuted
b. [] Copy from a prior application (37 CFR 1.63(d))
(for continuation/divisional with Box 17 completed)
[Note Box 5 below]
i. [] DELETION OF INVENTOR(S)
Signed statement attached deleting inventor(s) named in the prior application, see 37 CFR 1.63(d)(2) and 1.33(b).

5. [] Incorporation By Reference
(usable if Box 4b is checked)
The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied under Box 4b, is considered as being part of the disclosure of the accompanying application and is hereby incorporated by reference therein.

6. Microfiche Computer Program *(Appendix)*

7. []Nucleotide and/or Amino Acid Sequence Submission
(if applicable, all necessary)
a. [] Computer Readable Copy
b. [] Paper Copy (identical to computer copy)
c. [] Statement verifying identity of above copies

ACCOMPANYING APPLICATION PARTS

8. [X] Assignment Papers (cover sheet & document(s))
9. [] 37 CFR 3.73(b) Statement [] Power of Attorney
(when there is an assignee)
10. [] English Translation Document *(if applicable)*
11. [] Information Disclosure Statement (IDS)/PTO-1449
[] Copies of IDS Citations
12. [] Preliminary Amendment
13. [X] Return Receipt Postcard (MPEP 503)
(Should be specifically itemized)
14. [] Small Entity Statement(s)
[] Statement filed in prior application, Status still proper and desired
15. [] Certified Copy of Priority Document(s)
(if foreign priority is claimed)
16. [] Other

17. If a CONTINUING APPLICATION, *check appropriate box and supply the requisite information:*
[] Continuation [] Divisional [] Continuation-in-part (CIP) of prior Application No.

18. CORRESPONDENCE ADDRESS

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August 27, 1999

Battery

This application is based on application No.10-245119 filed in Japan on Aug. 31,1998, the content of which incorporated hereinto by reference.

Background of the Invention

This invention relates to a battery in which a lead (an electrically conducting lead, not the element Pb) plate connected to an electrode assembly is welded to the bottom plate of an external case by an energy beam such as a laser.

The following describes fabrication of a prior art battery in which a lead plate connected to an electrode assembly is welded to the bottom plate of an external case.

(1) A laminate of positive electrode plate, negative electrode plate, and separator in between, is rolled into a spiral shape to form the electrode assembly. The spiral shaped electrode assembly is formed with a center hole to insert an electrode rod for weld connection.

(2) The electrode assembly is inserted into a circular cylindrical external case with a bottom.

(3) A lead plate connected to the bottom of the electrode assembly is weld attached to connect it to the bottom of the external case. As shown in Fig. 1, an electrode rod 2 for weld connection is inserted into the electrode assembly 1 center hole, and the lead plate 4 is pushed by the electrode rod 2 against the bottom plate of the external case 5 and welded.

(4) A lead plate which draws out of the top of the electrode assembly 1 is connected to an electrode on a sealing lid which closes off the opening at the top of the external case 5. After the external case is filled with electrolyte, the sealing lid is fixed to the opening in the external case. The external case is sealed in an airtight fashion by the sealing lid.

This process has the characteristic that the lead plate 4 connected to the electrode assembly 1 can be reliably welded and fixed to the bottom plate of the external case 5. However, a battery of this configuration must be provided with a center hole in the middle of the electrode assembly 1, and this center hole must have a diameter larger than the electrode rod for weld connection. Therefore, the actual volume of the electrode assembly is reduced and the battery's capacity is decreased. Increasing battery capacity by reducing the size of the electrode assembly center hole may be considered, but when center hole size is reduced, fitting the electrode rod in the center hole becomes a problem.

Technology for connecting a lead plate to the bottom of an external case by laser welding from outside the case has been developed to eliminate the drawbacks of a battery with the configuration described above (Japanese Non-examined Patent Publications No. 4-162351 issued on June 5,1992 and No. 8-293299 issued on Nov. 5,1996). These and other disclosures cite batteries which do not use an electrode rod for weld connection. As shown in Fig. 2, an energy beam such as a laser is applied to the bottom plate 25A of the external case 25 from outside the case. The energy beam fuses a portion of the bottom plate 25A and the lead plate 24 to weld and attach the lead plate 24 to the bottom plate 25A.

As shown in Fig.2, there is no need to provide a center hole in the electrode assembly 21 of a battery in which an energy beam such as a laser beam is applied from outside the case to weld the lead plate to the bottom plate. Consequently, this type of battery has the characteristic that the actual electrode assembly volume and battery discharge capacity can be increased. However, in this type of battery in which the lead plate is weld attached from outside the external case, the lead plate can fail to reliably weld attached to the bottom plate. For example, with the electrode assembly inserted into the external case, if the lead plate is separated from the bottom plate, the bottom plate of the external case will fuse but the lead plate will not, and the energy

beam will not be able to reliably weld attach the lead plate to the bottom plate. In addition, if foreign material or contamination is between the lead plate and bottom plate, the energy beam will also fail to make a reliable weld attachment. In particular, whether or not the lead plate is weld attached to the bottom plate and what kind of attachment is made cannot be determined from outside this type of battery. Since evaluation of battery quality is difficult, it is extremely important to make weld attachments more reliably.

This invention was developed to solve these types of problems. It is thus a primary object of the present invention to provide a battery that can reliably weld attach a lead plate to an external case.

The above and further objects and features of the invention will more fully be apparent from the following detailed description with accompanying drawings.

Summary of the Invention

The battery has an electrode assembly inserted into a cylindrical external case. A lead plate connected to the electrode assembly is weld attached to inner surface of the external case by an energy beam applied from outside the external case.

Further, the battery of the present invention is provided with a projection which projects from the inner surface of the external case. An energy beam is applied to the projection from outside the external case to weld attach the inner surface of the projection to the lead plate.

A battery of this configuration has the characteristic that the lead plate can be reliably weld attached to the external case. This is because the projection in the external case makes reliable contact with the lead plate. The external case and lead plate can be reliably weld attached by application of an energy beam, such as a laser, to the projection which has its inner surface in contact with the lead plate. In particular, a battery, in which the lead plate and

external case can be reliably contacted and welded, also reliably prevents separation of the lead plate and external case due to mechanical shock.

In the battery of the present invention, the projection is disposed in a still more preferable arrangement for contact and weld attachment to the lead plate by curving the projecting surface to its center or by making a conical shaped projection.

Further, the lead plate of the battery can be provided with a flexible deforming piece, and the projection in the external case can be weld attached to this flexible deforming piece. In addition, the flexible deforming piece can jut outwards towards the projection in the external case to further improve connection of the lead plate and the external case.

Anti-corrosive coating can be used to coat the region of the battery where the energy beam is applied from outside the external case. This effectively prevents corrosion of the region of energy beam application, and contact resistance problems can be avoided via the anti-corrosive coating.

Brief Description of the Drawings

Fig. 1 is a cross section view showing a prior art battery fabrication method.

Fig. 2 is a cross section view showing another fabrication method of a prior art battery.

Fig. 3 is a cross section view showing an embodiment of a battery of the present invention.

Fig. 4 is a cross section view showing the bottom of the external case of the battery shown in Fig. 3.

Fig. 5 is a cross section view showing the bottom of the external case of a battery of another embodiment of the present invention.

Fig. 6 is a bottom view of the external case shown in Fig. 4.

Fig. 7 is a cross section view showing the bottom region of a battery of

another embodiment of the present invention.

Fig. 8 is a plan view showing the lead plate contained at the bottom of the battery shown in Fig. 3.

Fig. 9 is a plan view showing the lead plate contained at the top of the battery shown in Fig. 3.

Fig. 10 is an enlarged cross section view of a lead plate.

Fig. 11 is a cross section view showing the disposition of a lead plate for weld attachment to an electrode assembly.

Fig. 12 is a front view showing another type of lead plate for incorporation into a battery of the present invention.

Detailed Description of the Invention

The battery shown in Fig. 3 is a rechargeable battery such as a nickel hydride battery, a nickel cadmium battery, or a lithium ion battery, and is provided with a circular cylindrical external case 35, an electrode assembly 31 for insertion into this external case 35, and lead plates 33, 34 for connecting the electrode assembly 31 to the external case 35. Although the external case of the battery shown in Fig. 3 has a circular cylindrical shape, the external case of the battery of the present invention is not limited to a circular cylindrical shape. Although not illustrated, the external case may also take on, for example, a rectangular cylindrical shape or an elliptical cylindrical shape.

The external case 35 is made of iron or steel with nickel plated surfaces. The material for the external case 35 is the optimum metal selected considering the type of battery and its characteristics. For example, the external case 35 may also be made of stainless steel, aluminum, or aluminum alloy. The open region at the upper end of the metal external case 35 is sealed closed in an airtight fashion by the sealing lid 37. The sealing lid 37 of Fig. 3 is fixed in place on the external case 35 in an electrically insulating fashion by a caulked junction structure. The sealing lid may also be fixed on the external case in an

airtight fashion by a method such as laser welding. This configuration of sealing lid insulates and holds an electrode stationary. The sealing lid 37 fixes one terminal of the battery in place.

As shown in Figs. 3 and 4, the external case 35 is provided with a projection 35a in the region where the lead plate 34 is welded and fixed to the external case 35. A projection 35a is provided on the bottom plate 35A of the external case 35 of the battery shown in the figures, and the lead plate 34 is weld attached to this projection 35a. As shown in the bottom view of Fig. 6, the external case 35 is provided with a projection 35a at the center of the bottom plate 35A. An external case 35 provided with a projection 35a in this location has the characteristic that the location for weld attachment of the lead plate 34 by an energy beam operation such as laser welding can be easily and accurately aligned. This is because the location for energy beam weld attachment of the lead plate 34 does not change regardless of the position to which the external case 35 has rotated. However, there is no requirement to locate the projection at the center of the bottom plate. Further, the projection is not required to be provided on the bottom plate. For example, as shown in Fig. 7, the projection may also be provided on a side-wall of the external case 75. However, regardless of where the projection is provided, the lead plate 74 is weld attached to the projection 75a.

The outside diameter of the projection 35a is designed to an optimum value considering the area of the weld attach. If the diameter of the projection 35a is made small, the top of the projection can be reliably weld attached to the lead plate. However, if the projection diameter is too small, the weld attach area between the lead plate and external case becomes smaller.

Making the projection 35a jut high up from the inner surface of the external case 35 improves the situation for weld attachment of the projection 35a and the lead plate 34. However, making the projection 35a project high upwards pushes the electrode assembly 31, which inserts into the external case 35, upwards. Consequently, this makes it necessary to reduce the height

of the electrode assembly 31, and this reduces the real capacity of the electrode assembly.

As shown in Fig. 4, the projection 35a is shaped with its convex surface curved around the central protrusion. Or, as shown in Fig. 5, the projection 55a protrudes outward in a conical shape. In a battery with a projection having a protruding surface in one of these configurations, the lead plate 54 contacts the projection 55a without gaps or voids. Therefore, a battery of this type has the characteristic that the lead plate 54 and projection 55a can be more reliably weld attached. However, the protruding surface of the projection 55a may also be planar.

The electrode assembly 31 is a laminate of a positive electrode plate, a negative electrode plate, and a separator in between. The battery shown in Fig. 3 has a stack of positive electrode plate, negative electrode plate, and intervening separator rolled together. This spiral shaped electrode assembly 31 is inserted into the circular cylindrical external case 35. The spiral electrode assembly 31 may also be pressed from both sides to distort it into an elliptical shape for insertion into an elliptical shaped or rectangular shaped external case. Further, an electrode assembly for insertion into a square cylindrical external case can also be fabricated by cutting a plurality of positive electrode plate and negative electrode plate sheets, and stacking them with separator in between.

The electrode assembly 31 has lead plates 33, 34 connected to the positive and negative electrode plates. The lead plates 33, 34 are disposed at the top and bottom of the electrode assembly 31 and are connected to the positive and negative electrode plates. As shown in Fig. 3, positive and negative electrode plate core material projects upward and downward from the electrode assembly 31, and the lead plates 33, 34 are connected to these projections. In the electrode assembly 31 in the figures, the electrode plate 34 disposed at the bottom of the electrode assembly 31 is connected to the external case 35. The electrode plate 33 disposed at the top of the electrode

assembly 31 is connected to the sealing lid 37.

As shown in Figs. 8 and 9, the lead plates 33, 34, which connect to the top and bottom of the electrode assembly 31, are cut from metal plate in disk shapes smaller than the inside of the external case 35. As shown in Fig. 9, the lead plate 33 which connects to the top surface of the electrode assembly 31 has a lead strip 33A projecting from its periphery. The lead strip 33A connects to the sealing lid 37, which is electrically insulated from, and attaches to the open region of the external case 35. A lead plate 33 of the shape shown in Fig. 9 may also be used to connect the bottom surface of the electrode assembly to a side-wall of the external case.

As shown in the cross section view of Fig. 11, these types of lead plates 33, 34 are pressed against the electrode assembly 31 via a welding electrode 38, and reliably connected by resistive electric welding. A plurality of holes 39 are opened through the lead plates 33, 34 shown in Figs. 8 and 9 to reliably connect the lead plates 33, 34 electrically to the electrodes of the electrode assembly 31. As shown in the enlarged cross section view of Fig. 10, projections 310 are provided extending downward from the periphery of the holes 39 in the lead plates 33, 34. The projections 310 are connected to the electrode plates of the electrode assembly. Further, as shown in Fig. 9, the lead plate 33, which connects to the top of the electrode assembly 31, is provided with slits 313 on either side of a center hole 311 to reduce unnecessary electric current during resistive electric welding.

As shown in Fig. 8, the lead plate 33, which connects to the top of the electrode assembly 31, is provided with a U-shaped cut-out 312, and a flexible deforming piece 34A is provided inside this cut-out 312. The flexible deforming piece 34A protrudes outwards towards the projection 35a in the external case 35. The flexible deforming piece 34A is approximately at the center of the lead plate 34, and is weld attached to the external case 35 projection 35a.

Since lead plates 33, 34 in a battery of this configuration can connect to the electrode assembly 31 at a plurality of locations, the battery has excellent

high current characteristics. This is because internal resistance can be made small. Further, a battery of this configuration also has the characteristic that the lead plate 34 can be reliably weld attached to the bottom plate 35A via an energy beam. This is because the electrode assembly 31 can be inserted into the external case 35 and the lead plate 34 can be put in intimate contact with the bottom plate 35A of the external case.

However, the battery of the present invention is not limited to a lead plate, which connects the electrode assembly to the external case, according to the structure described above. For example, the lead plate may also have a band shape as shown in Fig. 12. This lead plate 124 connects to exposed core material of an electrode, extends out from the bottom of the electrode assembly, and its end weld attaches to the inner surface of the external case. This type of lead plate 124 may also extend out from the side of the electrode assembly and weld attach to a side-wall of the external case as shown in Fig. 7.

The lead plate 34 is weld attached to the inner surface of the external case 35. An energy beam such as a laser beam or an electron beam, etc. is used as a method of weld attaching the lead plate 34. The energy beam fuses both the external case 35 and the lead plate 34 to weld attach the lead plate 34 and the external case 35. As shown in Fig. 4, a laser beam is shined at a wide region, which includes the entire projection 35a, to weld attach the lead plate 34 and the external case 35.

When an energy beam such as a laser beam is applied to the outer surface of the external case 35, corrosion resistant metal plating, which coats the surface of the external case 35, loses its effectiveness. Consequently, the region of energy beam application can easily corrode. This drawback can be eliminated by coating the region of energy beam application with an anti-corrosive coating 36, as shown in the enlarged portion of the cross section view of Fig. 3. However, when anti-corrosive coating 36 is applied to the bottom surface of the external case 35, the anti-corrosive coating 36 can be the cause

of contact resistance during battery operation. This is because non-conducting organic coating material is used as the anti-corrosive coating 36. This drawback can be eliminated by mixing conductive material such as carbon or metallic powder into the anti-corrosive coating 36.

The anti-corrosive coating 36 can be sprayed in aerosol form or applied using a paint brush. Further, the anti-corrosive coating 36 may also be sprayed from a miniature nozzle according to ink-jet technology. The ink jet method has the characteristic that a precise thickness of anti-corrosive coating can be applied to the precise location of energy beam application. In addition, the anti-corrosive coating 36 can also be applied at the same time the date of manufacture and the usable date are printed on the external case of the battery by ink-jet.

[Embodiments]

[Embodiment 1]

Nickel cadmium batteries were fabricated by the following process, and lead plate to external case connections were tested. An external case provided with a projection 35a in the center of the bottom surface, as shown in Fig. 4, was used. The projection 35a was shaped with its convex surface curved around the central protrusion. The outside diameter of the projection 35a was approximately 2mm, the height of the projection was 0.2mm, and the radius of curvature of the protruding surface was 15mm.

As a lead plate 34, which connects to the bottom surface of the electrode assembly 31, a configuration provided with a flexible deforming piece 34A, as shown in Fig. 8, was used. A flexible deforming piece 34A, which protruded outwards approximately 0.2mm was used.

An electrode assembly rolled into a spiral shape with a separator between electrodes and lead plates 33, 34 weld attached to both ends was inserted in the external case 35 with the above configuration. Lead plates 33, 34 with a plurality of holes 39 and projections 310 provided at the periphery of the holes 39 were used. The electrode assembly was inserted into the external

case, a laser was applied to the indentation corresponding to the projection 35a provided in the bottom surface of the external case, and the lead plate 34 was weld attached to the external case 35. As a coating on the laser weld region at the outer bottom surface of the external case, Hitachi Manufacturing LTD. [JP-K28] was applied. After weld attaching the lead plate 33 connected to the top surface of the electrode assembly to the sealing lid 37, electrolyte was added, and the opening in the external case was closed off with the sealing lid 37 to complete fabrication of a nickel cadmium battery.

[Embodiment 2]

Nickel cadmium batteries were fabricated by the same process as embodiment 1 except the lead plate connected to the bottom surface of the electrode assembly had no flexible deforming piece. The region of the lead plate for weld attachment to the external case was planar for this battery.

[Comparison Example]

Nickel cadmium batteries were fabricated by the same process as embodiment 1 except the bottom surface of the external case had no projection.

The following shows comparison of lead plate to external case weld attach success ratios for batteries fabricated as described above.

Batteries of Embodiment 1	100%
Batteries of Embodiment 2	98%
Batteries of the Comparison Example	97%

From these test results, batteries of embodiment 1 and embodiment 2 had lead plates and external cases reliably connected. In particular, there was no failure of lead plate to external case weld attach for batteries of embodiment 1.

As this invention may be embodied in several forms without departing from the spirit of essential characteristics thereof, the present embodiment is therefore illustrative and not restrictive, since the scope of the invention is defined by the appended claims rather than by the description preceding them,

and all changes that fall within the meets and bounds of the claims or equivalence of such meets and bounds thereof are therefore intended to be embraced by the claims.

What is claimed is:

1. A battery comprising:

(1) a cylindrical shaped external case having a projection jutting from its inner surface;

(2) an electrode assembly inserted into the external case; and

(3) a lead plate, which is connected to the electrode assembly, and which is connected to the projection jutting from the inner surface of the external case by an energy beam applied to the external case from outside the external case.

2. A battery as recited in claim 1 wherein the external case is a circular cylindrical shape, and a projection is provided at the center of the bottom plate of the external case.

3. A battery as recited in claim 2 wherein a spiral shaped electrode assembly is inserted into the circular cylindrical shaped external case.

4. A battery as recited in claim 1 wherein a projection for connection to the lead plate is provided on a side-wall of the external case.

5. A battery as recited in claim 1 wherein the shape of the external case is a rectangular cylinder, an elliptical cylinder, or a cylinder shape between rectangular and elliptical (super-elliptical).

6. A battery as recited in claim 5 wherein a spiral shaped electrode assembly is pressed from both sides to deform it into an ellipse and inserted into an elliptical external case.

7. A battery as recited in claim 5 wherein an electrode assembly, formed by cutting a plurality of positive electrode plate and negative electrode plate

sheets and stacking them with separator in between, is inserted into a rectangular cylindrical external case.

8. A battery as recited in claim 1 wherein the protruding surface of the projection provided on the external case is curved around the central protrusion.

9. A battery as recited in claim 1 wherein the protruding surface of the projection provided on the external case juts out in a conical shape.

10. A battery as recited in claim 1 wherein a flexible deforming piece is formed on the lead plate as a result of a U-shaped cut-out around the flexible deforming piece, and the flexible deforming piece is weld attached to the projection on the external case.

11. A battery as recited in claim 10 wherein the flexible deforming piece projects outward towards the projection on the external case.

12. A battery as recited in claim 10 wherein the external case is circular cylindrical shaped, the lead plate is cut from metal plate in a disk shape smaller than the inside of the external case, and the flexible deforming piece is disposed at the approximate center of the lead plate.

13. A battery as recited in claim 12 wherein the lead plate has holes with projections around the peripheries of the holes, and the projections are connected to the electrode assembly.

14. A battery as recited in claim 1 wherein anti-corrosive coating is applied to the region of energy beam application outside the external case.

15. A battery as recited in claim 14 wherein the anti-corrosive coating is conductive.

Battery

Abstract

The battery has an electrode assembly inserted into a cylindrical external case. A lead plate connected to the electrode assembly is weld attached to the inner surface of the external case by an energy beam applied from outside the external case. The external case has a projection jutting from its inner surface. The energy beam is applied to the projection from outside the external case and weld attaches the lead plate to the inner surface of the projection.

FIG. 1

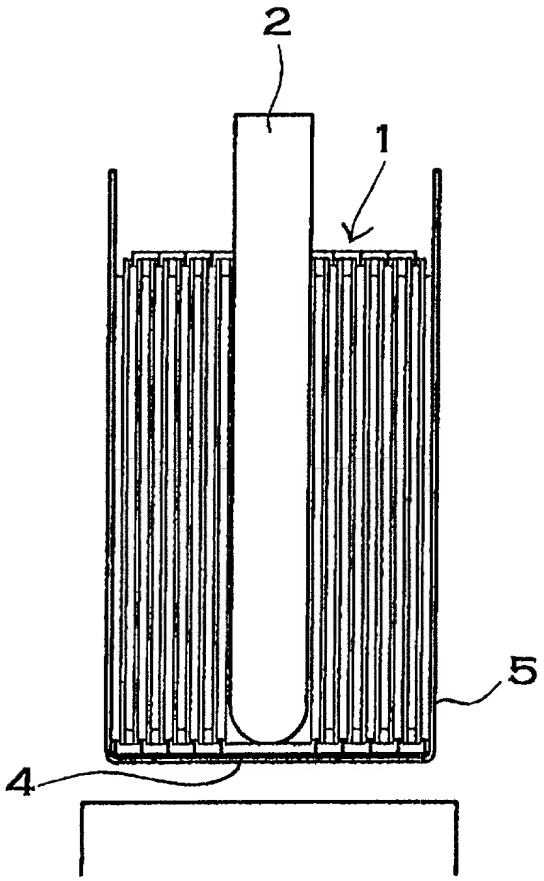


FIG. 2

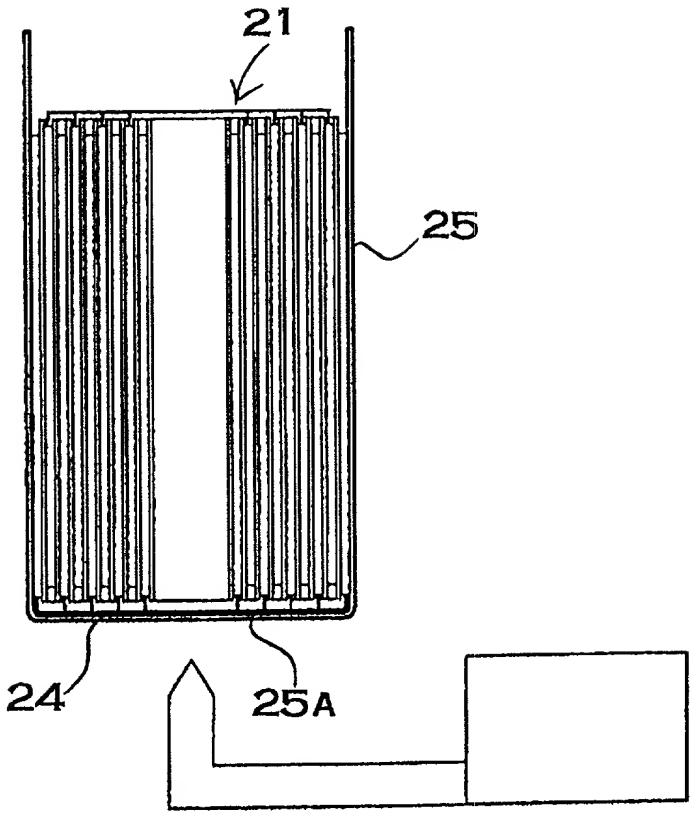


FIG. 3

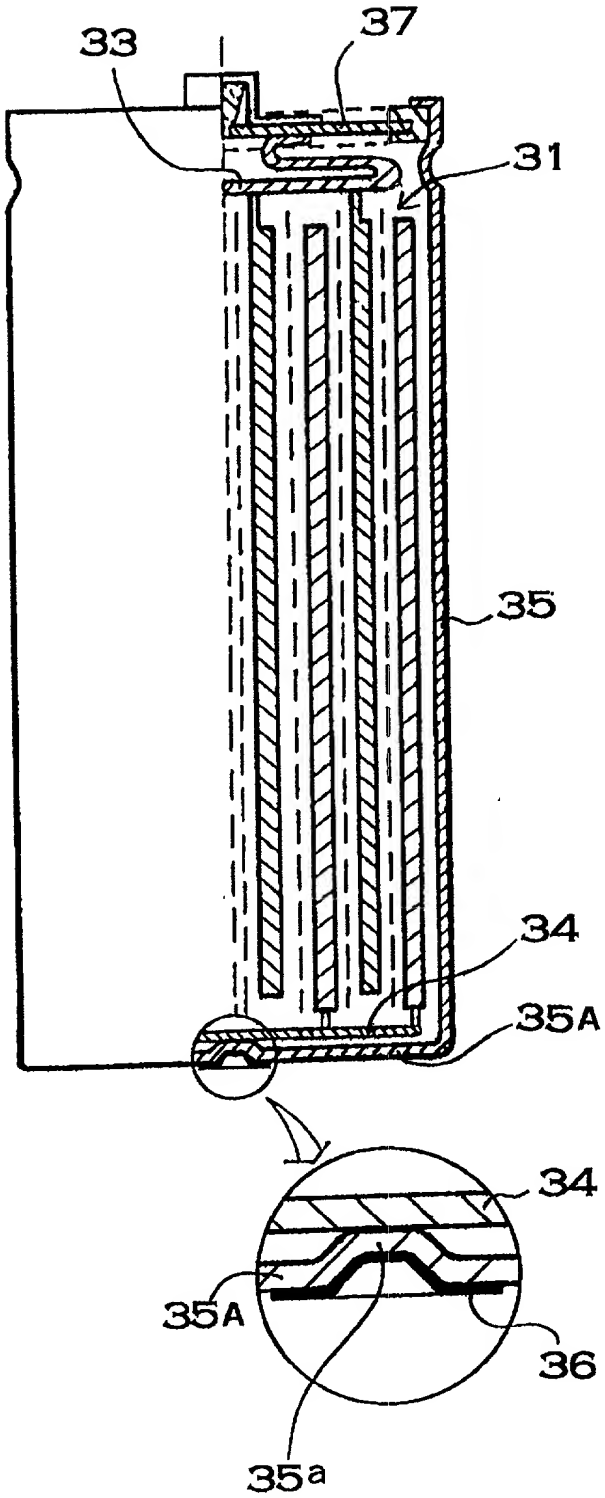


FIG. 4

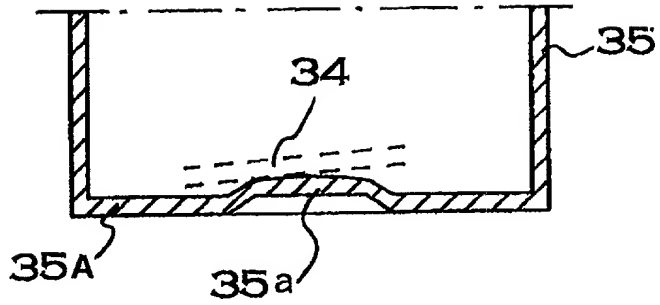


FIG. 5

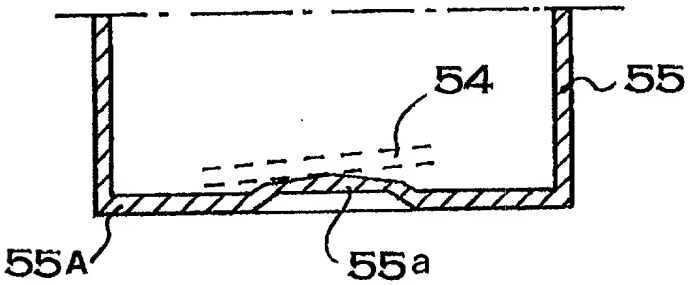


FIG. 6

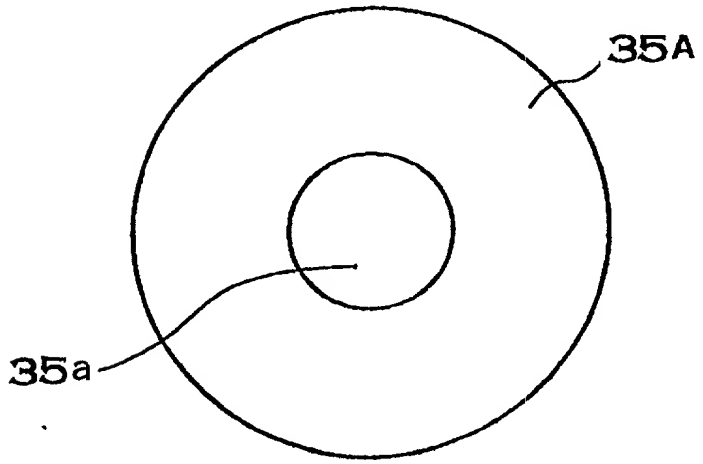


FIG. 7

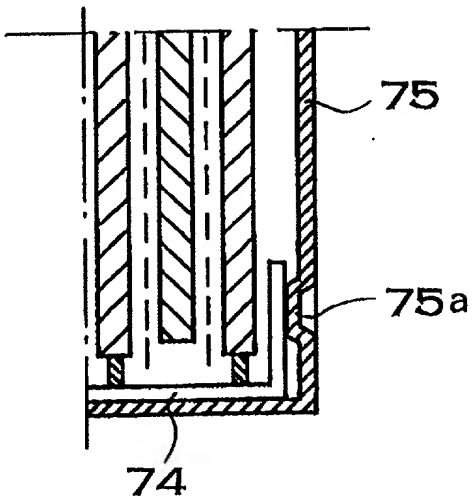


FIG. 8

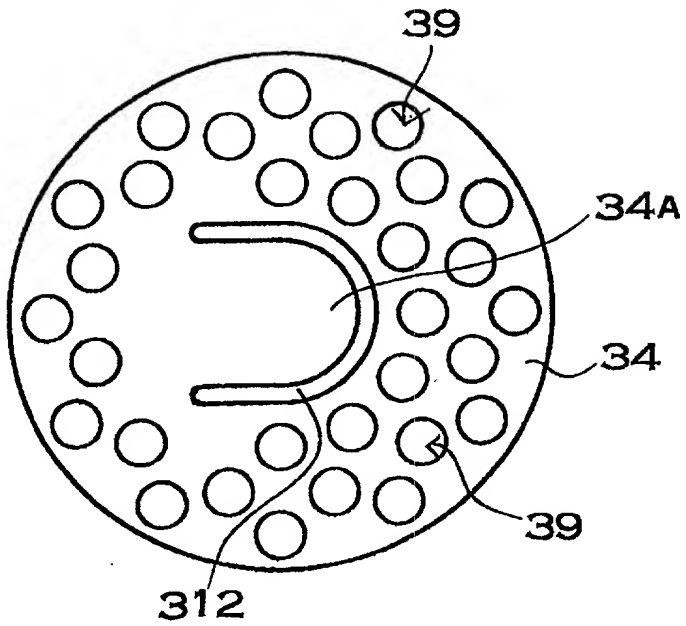


FIG. 9

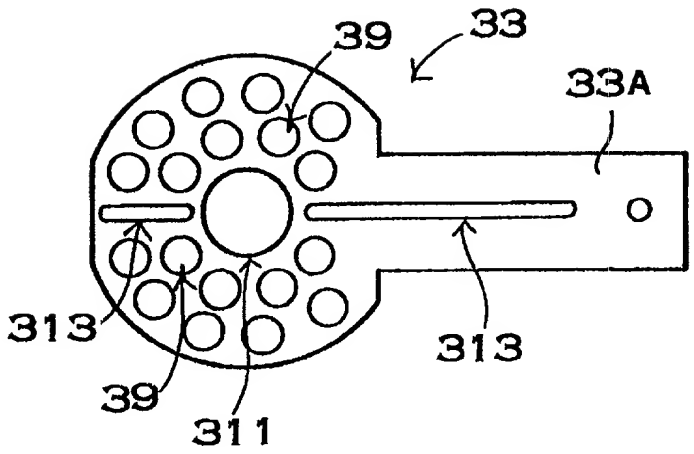


FIG. 10

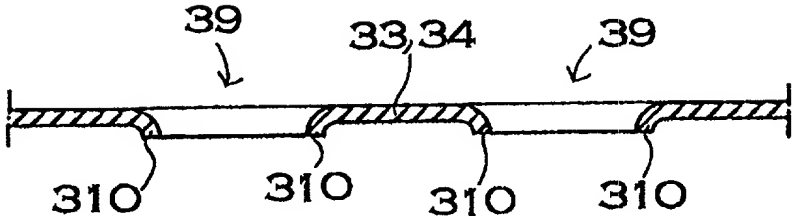


FIG. 11

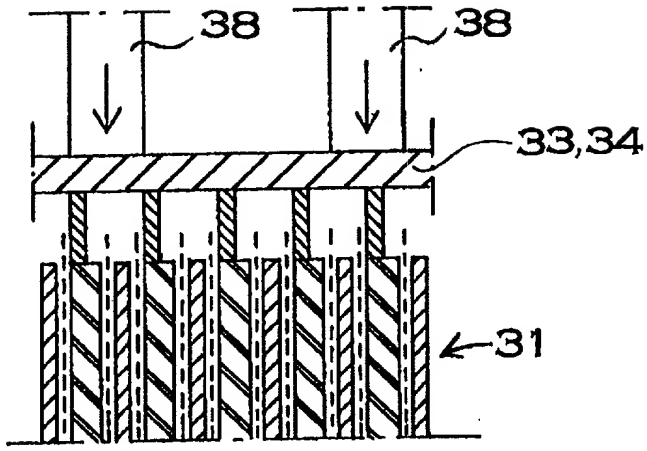
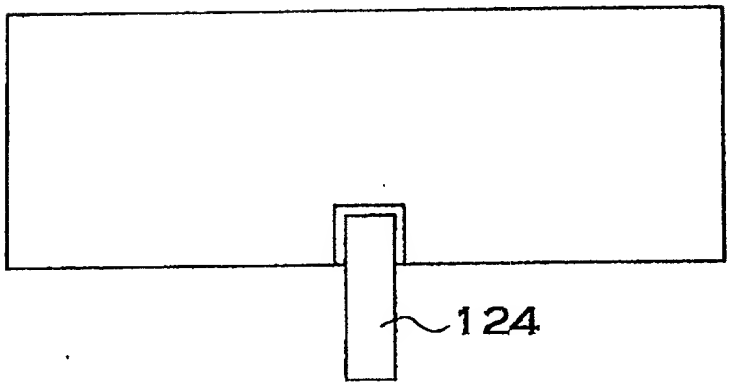


FIG. 12



DECLARATION AND POWER OF ATTORNEY FOR U.S. PATENT APPLICATION

(X) Original ( ) Supplemental ( ) Substitute ( ) PCT ( ) Design

As a below named inventor, I hereby declare that: my residence, post office address and citizenship are as stated below next to my name; that I verily believe that I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural inventors are named below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

Title: BATTERY

of which is described and claimed in:
(X) the attached specification, or
( ) the specification in the application Serial No. _____ filed _____;
and with amendments through _____ (if applicable), or
( ) the specification in International Application No. PCT/_____, filed _____, and as amended on _____ (if applicable).

I hereby state that I have reviewed and understand the content of the above-identified specification, including the claims, as amended by any amendment(s) referred to above.

I acknowledge my duty to disclose to the Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I hereby claim priority benefits under Title 35, United States Code, §119 (and §172 if this application is for a Design) of any application(s) for patent or inventor's certificate listed below and have also identified below any application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

COUNTRY	APPLICATION NO.	DATE OF FILING	PRIORITY CLAIMED
Japan	245119/1998	August 31,1998	Yes

I hereby claim the benefit under Title 35, United States Code, §120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disicosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose information material to patentability as defined in Title 37, Code of Federal Regulations, §1.56 which occurred between the filing date of the prior application and the national or PCT international filing date of this application.

APPLICATION SERIAL NO.	U.S. FILING DATE	STATUS: PATENTED, PENDING, ABANDONED

And I hereby appoint John T. Miller, Reg. No. 21,120; Michael R. Davis, Reg. No. 25,134; Matthew M. Jacob, Reg. No. 25,154; Jeffrey Nolton, Reg. No. 25,408; Warren M. Cheek, Jr., Reg. No. 33,367; Nils E. Pedersen, Reg. No. 33,145 and Charles R. Watts, Reg. No. 33,142, who together constitute the firm of WENDEROTH, LIND & PONACK, L.L.P., attorneys to prosecute this application and to transact all business in the U.S. Patent and Trademark Office connected therewith.

I hereby authorize the U.S. attorneys named herein to accept and follow instructions from YASUHIRO TOYOSU as to any action to be taken in the U.S. Patent and Trademark Office regarding this application without direct communication between the U.S. attorneys and myself. In the event of a change in the persons from whom instructions may be taken, the U.S. attorneys named herein will be so notified by me.

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I further declare that all statements made herein of my own knowledge are true, and that all statements on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

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6th Inventor _____ Date _____

7th Inventor _____ Date _____

The above application may be more particularly identified as follows:

U.S. Application Serial No. _____ Filing Date _____

Applicant Reference Number _____ Atty Docket No. _____

Title of Invention _____